AMENDMENTS TO THE SPECIFICATION

Please replace paragraphs [0021] – [0022] with the following amended paragraphs:

[0021] Figure 7 is an isometric view of an exemplary thermal <u>insulating</u> plate 180 suitable for embodiments of the processing system 100 described herein.

[0022] Figure 7A is a cross sectional view of one exemplary design of the thermal <u>insulating</u> plate 180.

Please replace paragraph [0025] with the following amended paragraph:

[0025] Figure 1 is a schematic, cross-sectional view of a processing system 100 capable of depositing various materials, films, and layers on a work piece surface using multiple deposition techniques. The processing system 100 includes a gas distribution assembly 130 disposed on an upper portion of a chamber body 102. The chamber body 102 includes a pumping plate 162, a liner 167, a slit valve 108, and a substrate support 112 disposed therein. The slit valve 108 is formed within a side wall 104 of the chamber body 102 and allows transfer of a workpiece (not shown) to and from the interior of the chamber body 102 without compromising the fluid-tight seal formed between the gas distribution assembly 130 and the chamber body 102. Any conventional workpiece transfer assembly (not shown) may be used, such as a robotic wafer transfer assembly, for example. One example of a conventional robotic wafer transfer assembly is described in the commonly assigned U.S. Patent ~~titled "Multi-chamber Integrated Process System", (U.S. Patent~~ No. 4,951,601 [[)]], which is incorporated by reference herein.

Please replace paragraph [0027] with the following amended paragraph:

[0027] The liner 167 is disposed about the support pedestal 112 and circumscribes the interior, vertical surfaces of the chamber body 102. The liner 167 is

constructed of any process compatible material ~~named above~~, such as aluminum, and is preferably made of the same material as the chamber body 102. A purge channel 168 is formed within the liner 167 and is in fluid communication with a pumping port 117 that extends through a side wall of the chamber body 102. A pump system 118 is connectable to the chamber body 102 adjacent the pumping port 117, and helps direct the flow of fluids within the chamber body 102.

Please replace paragraph [0033] with the following amended paragraph:

[0033] Still referring to Figure 1, the gas distribution assembly 130 includes a head assembly 131 and a thermal plate 180 disposed on a chamber lid 132, each having at least a portion of an expanding conduit 134 formed therethrough. A lower surface 160 of the lid 132 includes a gradual, tapering slope/recess that extends from a central portion thereof, adjacent the expanding conduit 134, to a peripheral portion thereof. The recess formed on the lower surface 160 is sized and shaped to substantially cover the substrate 110 disposed below. It is believed that the tapered lower surface 160 provides a more uniform deposition of the gas across the surface of the substrate 110. The tapered surface 160 creates a more uniform velocity, thereby delivering a uniform concentration of gas across the surface of the substrate 110.

Please replace paragraph [0039] with the following amended paragraph:

[0039] Figure 3 is a top cross-sectional view of the gas delivery assembly 130 along lines 3-3 in Figure 2. The delivery conduits 250A, 250B, are positioned tangentially to expanding conduit 134. During use, a gas flowing through the delivery conduits 250A, 250B initially flows in a circular direction as shown by arrows 310A, 310B. Providing gas tangentially produces a circular, laminar flow through the expanding conduit ~~234~~ 134, resulting in an improved flow distribution across the surface of the substrate ~~surface~~ 110 and an improved purge of the inner surface of the expanding conduit 134. In comparison, a turbulent flow may not uniformly flow within

the expanding conduit 134 and may create areas within the expanding conduit 134 where there is no gas flow.

Please replace paragraph [0041] with the following amended paragraph:

[0041] Although the exact flow pattern through the expanding conduit 134 is not known, it is believed that the initial circular, laminar flow 310A, 310B (shown in Figure 3) progresses into a laminar "vortex" or "spiral" flow pattern (represented by arrows 402A, 402B) as the gases travel through the expanding conduit 134. A distance 410 between the delivery conduits 250A, 250B and the substrate 110 is designed such that the [["]] vortex [["]] flow <u>pattern</u> 402A, 402B decreases in velocity such that a substantially vertical flow path is created. It is believed that the [["]] vortex [["]] flow <u>pattern</u> 402A, 402B provides superior mixing of the gases, if desired, and provides an efficient purge or sweep of the inner surface of the expanding conduit 134, whereas, the substantially vertical flow allows better deposition on the <u>surface of the</u> substrate ~~surface~~ 110. In one aspect, the expanding conduit 134 is mirror polished to help produce or encourage the laminar flow of gases therethrough.

Please replace paragraphs [0045] – [0053] with the following amended paragraphs:

[0045] The radial mixer 510 has an inner wall 515 located between the expanding conduit 134 and the annular mixing channel 520. One or more passageways ~~530, such as~~ <u>528 having</u> nozzles <u>530</u>, are formed through the inner wall 515 to allow fluid communication between the mixing channel 520 and the expanding conduit 134. The nozzles 530 are disposed radially and are substantially evenly distributed along an outer circumference of the expanding conduit 134. The nozzles 530 may be disposed substantially normal to the expanding conduit 134. Alternatively, the nozzles 530 may be disposed at an angle relative to normal, such as between about -60° to about +60°. In one aspect, the number of nozzles 530 may be twelve; however, other numbers, shapes and/or distributions of nozzles 530 may also be employed.

[0046] At least one gas inlet (two gas inlets are shown 525, 526) is in communication with the mixing channel 520 from outside of the radial mixer 510. Typically, the gas inlets 525, 526, are in fluid communication with one or more sources (not shown) of reactant gases, precursor gases, carrier gases, purge gases, and any combination thereof. The gas inlets 525, 526, provide the one or more processing gases from their respective sources (not shown) to the annular mixing channel 520 where the gases mix prior to entering the expanding conduit 134 via the nozzles 530.

[0047] The gas inlets 525, 526 are oriented such that they are not directly aligned with any one of the nozzles 530. For instance, the gas inlets 525, 526 are offset relative to the nozzles 530 so that any one of the respective velocities of the gases emerging from any one of the gas inlets 525, 526 does not affect the local pressure of another. As a result, a thorough mixing of the gases is achieved within the mixing channel 520, and a substantially equal flow of gas enters the expanding conduit 134 through the nozzles 530.

[0048] Figure 5B shows an enlarged vertical sectional view of another embodiment of the second gas delivery sub-assembly 500. The second gas delivery sub-assembly 500 includes a gap or a passageway, such as gap 555, formed in a lower surface of the inner wall 515. Although ~~now~~ not shown, it is contemplated to have both nozzles 530 and a gap 555 formed through the inner wall 515. In one aspect of this embodiment, the height of the gap 555 may be constant across the diameter of the inner wall 515. In another aspect of this embodiment, the height of the gap 555 may vary across the diameter of the inner wall 515 to compensate for the pumping effects created within the chamber 102. For example, the height of the gap 555 nearest the pumping port 117 may be half the height of the gap 555 opposite the pumping port 117 to choke off the fluid flow where the pressure differential is the greatest. By changing the height of the gap 555, the fluid dynamics of the gas flowing through the mixing channel 520 can be better controlled to provide better mixing or better distribution through out the expanding conduit 134 and the chamber body 102.

[0049] Figure 6 is a schematic horizontal sectional view of the second gas delivery system 500 along line 6-6 of Figure 5. The passageways 528 and nozzles 530 are arranged and dimensioned to provide substantial flow resistance to the gas flowing from the mixing channel 520 to the expanding conduit 134. The substantial resistance to gas flow provided by the nozzles 530 allows a substantially equal rate of flow to be achieved through each of the nozzles 530, providing a full and even flow distribution to the substrate 110.

[0050] Figure 6A is a schematic horizontal sectional view of an alternative embodiment of the second gas delivery system 500. In this embodiment, a plurality of tangentially disposed passageways 628 and nozzles 630 are formed within the inner wall 515 of the radial mixer 510 to provide a directional flow along an inner diameter of the expanding conduit 134. The nozzles 630 are preferably angled in the same direction to provide a clockwise flow pattern of the gases flowing therethrough. The directional flow provides a swirling effect that encourages mixing of the gases and attracts the flowing gases to the inner diameter 134A of the expanding conduit 134, delivering a full distribution of mixed gases to the substrate 110.

[0051] Figure 7 shows an isometric view of an exemplary thermal insulating plate 180 suitable for embodiments of the processing system 100 described herein. The thermal insulating plate 180 is an annular member that is disposed about the expanding conduit 134 between the head assembly 131 and the chamber lid 132, as depicted in Figures 1, 2, and 4. The insulating plate 180 thermally confines or isolates the head assembly 131 from the chamber lid 132, and is preferably made from a material, such as stainless steel for example, that has a low heat transfer coefficient. ~~In other words, any~~ A material that is ~~not~~ a ~~good~~ poor thermal conductor is preferred, so as to thermally insulate the head assembly 131 from the rest of the processing system 100, such as the chamber body 102 and the chamber lid 132 [[. As such]] to achieve better temperature control and better overall operability ~~is achieved~~.

[0052] Figure 7A shows a cross sectional view of one exemplary design of the thermal insulating plate 180. In this embodiment, a recess 181 is formed in both an

upper surface 182 and a lower surface 184 of the thermal insulating plate 180 to minimize the surface area of the thermal insulating plate 180 that would otherwise be in contact with the head assembly 131 and the chamber lid 132. The reduction of surface area further reduces heat transfer between the components. Consequently, the head assembly 131 remains relatively unaffected by the temperature of the chamber lid 132. Likewise, the chamber lid 132 remains relatively unaffected by the temperature of the head assembly 131. As a result, the temperature of the lid chamber 132 is easier to maintain since less heat/energy is being transferred across the thermal insulating plate 180.

[0053] Referring again to Figure 1, the processing system 100 may further include a controller 170, such as a programmed personal computer, work station computer, or the like, to control processing conditions. For example, the controller 170 may be configured to control flow of various process gases, carrier gases and purge gases through the valves 140A, 140B during different stages of a substrate process sequence. The controller 170 includes a processor 172 in data communication with memory, such as random access memory 174 and a hard disk drive 176. Typically, the controller 170 is in communication with at least the pump system 118, the power source 114, and valves 140A, 140B. In addition, the controller 170 may be configured to be responsible for automated control of other activities used in wafer processing---such as wafer transport, temperature control, chamber evacuation, among other activities, some of which are described elsewhere herein. An exemplary controller 170 is a chamber/application specific controller, such as a programmable logic computer (PLC) which is described in more detail in the ~~co-pending~~ commonly assigned U.S. Patent Application Serial No. 09/800,881, entitled "Valve Control System For ALD Chamber", filed on March 7, 2001, issued as U.S. Pat. No. 6,734,020, which is incorporated by reference herein.

Please replace paragraph [0056] with the following amended paragraph:

[0056] The term “compound” is intended to include one or more precursors, oxidants, reductants, reactants, and catalysts, or a combination thereof. The term

"compound" is also intended to include a grouping of compounds, such as when two or more compounds are introduced in a processing system at the same time. For example, a grouping of compounds may include one or more catalysts and one or more precursors. The term "compound" is further intended to include one or more precursors, oxidants, reductants, reactants, and catalysts, or a combination thereof in an activated or otherwise energized state, such as by disassociation or ionization. A wide variety of semiconductor processing precursors, compounds and reactants may be used. Examples may include titanium tetrachloride ($TiCl_4$), tungsten hexafluoride (WF_6), tantalum pentachloride ($TaCl_5$), titanium iodide (TiI_4), titanium bromide ($TiBr_4$), tetrakis(dimethylamido) titanium (TDMAT), pentakis(dimethyl amido) tantalum (PDMAT), tetrakis(diethylamido) titanium (TDEAT), tungsten hexacarbonyl ($W(CO)_6$), tungsten hexachloride (WCl_6), ~~tetrakis(diethylamido) titanium (TDEAT),~~ pentakis (ethyl methyl amido) tantalum (PEMAT), pentakis(diethylamido)tantalum (PDEAT), ammonia (NH_3), hydrazine (N_2H_4), monomethyl hydrazine ($CH_3N_2H_3$), dimethyl hydrazine ($C_2H_6N_2H_2$), t-butylhydrazine ($C_4H_9N_2H_3$), phenylhydrazine ($C_6H_5N_2H_3$), ~~2,2'-azoisobutane~~ <u>2,2'-azotertbutane</u> ($(CH_3)_6C_2N_2$), ethylazide ($C_2H_5N_3$), and nitrogen (N_2), for example.

Please replace paragraph [0069] with the following amended paragraph:

[0069] The tantalum-containing compound and the nitrogen-containing compound flow through the expanding conduit 134 within the vortex flow pattern 402<u>A, 402B</u>, resembling a sweeping action across the inner surface of the expanding conduit 134. The vortex flow pattern 402<u>A, 402B</u> dissipates to a downward flow <u>pattern</u> 404 toward the surface of the substrate 110. The gases then flow across the bottom surface 160 of the chamber lid 132 and across the surface of the substrate 110. The bottom surface 160 of the chamber lid 132, which is downwardly sloping, helps reduce the variation of the velocity of the gas flow across the surface of the substrate 110. Finally, the gases flow from the chamber body 102 into the pump system 118 via the apertures 162A formed in the pumping plate 162.

Please replace paragraph [0081] with the following amended paragraph:

[0081] During the CVD mode, a purge gas, such as argon for example, flows through the valves 140A, 140B into the expanding conduit 134 to promote mixing and to better distribute the DMAH and hydrogen gases across the surface of the substrate ~~surface~~ 110. The purge gas also prevents backflow of the deposition gases (DMAH and hydrogen) into the valves 140A, 140B. In one aspect, the valves 140A, 140B may pulse the argon gas into the expanding conduit 134 to create a wave-like effect. The wave-like effect is thought to pulsate the deposition gases providing better mixing. In another aspect, the valves 140A, 140B may be left "on" to deliver a continuous flow of argon into the expanding conduit 134.